# Stream Classification

Because of the great diversity of morphological features among rivers, a stream classification system was developed to stratify and describe various river types (Rosgen, 1994, 1996). The nature and range of the dependent form variables of river channels were delineated to help describe the variety of morphological stream types that do occur in nature. These types were not determined arbitrarily but rather were organized by measured data representing hundreds of rivers between 1969 and 1994 (Rosgen, 1994, 1996). Resultant stream types are a reflection of mutually adjusting variables that describe their unique sedimentological, hydraulic, morphological and biological characteristics.

Stream classification is based primarily on the measured bankfull stage morphology of the river because it is the bankfull stage that is responsible for shaping and maintaining the channel dimensions over time. However, rather than using the measured values of dimension, pattern and profile to define a stream type, the classification system is based on dimensionless morphological parameters required for scaling purposes.

Specific objectives of the stream classification system (Rosgen, 1994, 1996) are to: (1) predict a river's behavior from its morphological appearance based on documentation of similar response from similar types for imposed conditions; (2) stratify empirical hydraulic, sedimentological and biological relations by stream type by state (condition) to minimize variance; (3) provide a mechanism to extrapolate site-specific morphological data; (4) describe physical stream relations to complement biological and riparian ecosystem inventories and assist in establishing potential and departure states; and (5) provide a consistent, reproducible frame of reference for communicating stream morphology and condition among a variety of professional disciplines.

The stream classification system consists of a hierarchical assessment of channel morphology that includes four levels of assessment (Rosgen, 1994, 1996). The four levels provide the physical, hydrologic, sedimentological and geomorphic context for linking the driving forces and response variables at all scales of inquiry. The detail required at each level of assessment varies with the degree of resolution necessary to achieve the specific objectives previously stated.

*Level I* of the hierarchical assessment is the geomorphic characterization where streams are classified at a broad level on the basis of valley landforms and observable channel dimensions. Eight major morphological stream types can be identified (A, B, C, D, DA, E, F and G) using five initial definitive criteria: channel pattern (multiple-thread versus single-thread channels), entrenchment ratio, width/depth ratio, sinuosity and slope (**Figure A-1** and **Table A-1**, Rosgen, 1994, 1996). Entrenchment ratio is a measure of vertical containment described as the ratio of the flood-prone area width to bankfull width. The flood-prone area width is obtained at an elevation at two times the maximum bankfull depth. If the entrenchment ratio is less than 1.4 (± 0.2 to allow for the continuum of channel form), the stream is classified as entrenched or vertically contained (A, G, and F Stream Types) (Table 1). If the entrenchment ratio is between 1.4 and 2.2, (+ or – 0.2), the stream is moderately entrenched (B Stream Types). If the ratio is greater than 2.2, the stream is not entrenched (C, E and DA Stream Types). Additionally, some stream types are associated with valley types that have well-developed floodplains (C, D, E and

DA Stream Types), while other stream types are associated with valley types with no floodplains (A, B, certain D, G and F Stream Types). **Table 1** describes the additional criteria (channel pattern, width/depth ratio, sinuosity and slope) for each major stream type.

*Level II* is the morphological description that classifies stream types within certain valley types using field measurements of the same criteria necessary for the broad-level classification from specific channel reaches and fluvial features (**Figure A-2**, Rosgen, 1994, 1996). In addition, the initial stream type is further subdivided by its dominant channel material size: bedrock (1), boulder (2), cobble (3), gravel (4), sand (5) and silt/clay (6). In total, 41 primary stream types exist. Subcategories of slope are also utilized along a slope continuum where the combined morphological variables are consistent for a stream type. However, for a particular stream reach that is steeper or flatter than the normal range of that type, a small letter sub-category is used to best reflect actual variables (Rosgen, 1994, p. 181): a+ (steeper than 0.10), a (0.04–0.10; slopes typical of A Stream Types), b (0.02–0.04; slopes typical of B Stream Types), c (0.001–0.02; slopes typical of C Stream Types), and c- (less than 0.001).

The various categories and threshold ranges were obtained from field data representing over 800 rivers using frequency distributions from each major stream type grouping to establish the interrelations of morphological data. The parameter ranges are described by the frequency distributions summarized in Rosgen (1996, Chapter 5). In addition, Rosgen also describes the process-integration and interrelated morphologic, hydraulic and sedimentological characteristics of each primary stream type. **Table A-2** lists management interpretations by Level II stream types.

Due to the continuum of channel form and shifts in stream types along river reaches, the definitive criteria values can depart from the typical ranges for a given stream type. These instances are indicative of (1) a transition between stream types and valley types that occurs when changing from an upstream reach into a downstream reach (spatial variability), (2) a shift in stability or condition influenced by variables described in *Level III* (temporal variability), and/or (3) an equilibrium threshold shift trending toward a new stream type (temporal and spatial variability). In these instances, the variables that best represent the dominant morphological type must be determined.

*Level III* assesses stream condition to predict river stability (e.g., aggradation, degradation, sediment supply, streambank erosion and channel enlargement). The stream classification system was developed with an understanding that a stability evaluation must be conducted at a higher degree of resolution (*Level III* assessment) than morphological groupings (*Level II*). Channel stability assessments, however, must be stratified by stream type and valley type for extrapolation purposes. Additional form variables are identified by stream type and their definitive criteria to determine a state or condition. Various processes and stream channel response to imposed changes in the controlling variables can then be inferred using time-trend aerial photo analysis and detailed field measurements (Rosgen, 1994, 1996, 2006b). Variables assessed and introduced in this level include bank-height ratio (a measure of degree of channel incision determined as the lowest bank height divided by the bankfull maximum depth), meander width ratio (lateral containment or confinement measured by channel belt width divided by bankfull width), shear stress, shear velocity and total stream power. Prediction of streambank erosion (BANCS model; Rosgen, 1996, 2001, 2006/2009), hydraulic analysis (Rosgen, 1996, 2006/2009), sediment competence and transport capacity (Rosgen, 2006/2009), and quantitative indices for river stability are also collected at this level (Rosgen, 1996, 2006/2009).

Critical, but often difficult, in the stability assessments and interpretations is an understanding of what constitutes a natural process versus an acceleration of a natural process as streams can be stable, yet dynamic. It is essential to distinguish if the methods used in the river stability assessment predict the differences between natural, stable rates versus accelerated rates that may exceed a geomorphic threshold. The assessment requires a departure analysis of the existing condition reach from the reference reach condition to assist with these interpretations. Without such stability assessments for the reference and existing reaches, it is often difficult to understand the cause and consequence of change related to certain land uses that are the agents of disequilibrium.

*Level IV* is conducted to validate process-based assessments of stream condition, potential and stability as predicted from *Levels I–III*. Prediction of river system process is complex and uncertain; thus validation of the procedure is essential since restoration designs are based upon such predictions. Validation procedures include annual dimension, pattern, profile and material resurveys; annual streambank erosion studies; sediment competence validation; hydraulic relations using gauging stations or current meter measurements; and direct measurements of bedload and suspended sediment for the accurate estimate of sediment transport capacity. After reach conditions are verified, the validation data are used to establish empirical relationships for testing, validating and improving the prediction methods. In fact, the basic foundation of the stream classification system was developed from the author's *Level IV* field data collected over many years that were used to develop the prediction methodologies and for the interpretation and extrapolation of the basic relations. The field data involve sediment transport, streambank erosion rates, hydraulics and corresponding changes in the channel form variables, all of which are time-consuming and expensive to collect. It is necessary to validate the procedures for both the existing and reference reaches. In this manner, it is possible to measure natural streambank erosion rates and to obtain a wide range of natural variability of the dimensions, pattern and profile to determine acceptable rates and tolerances.

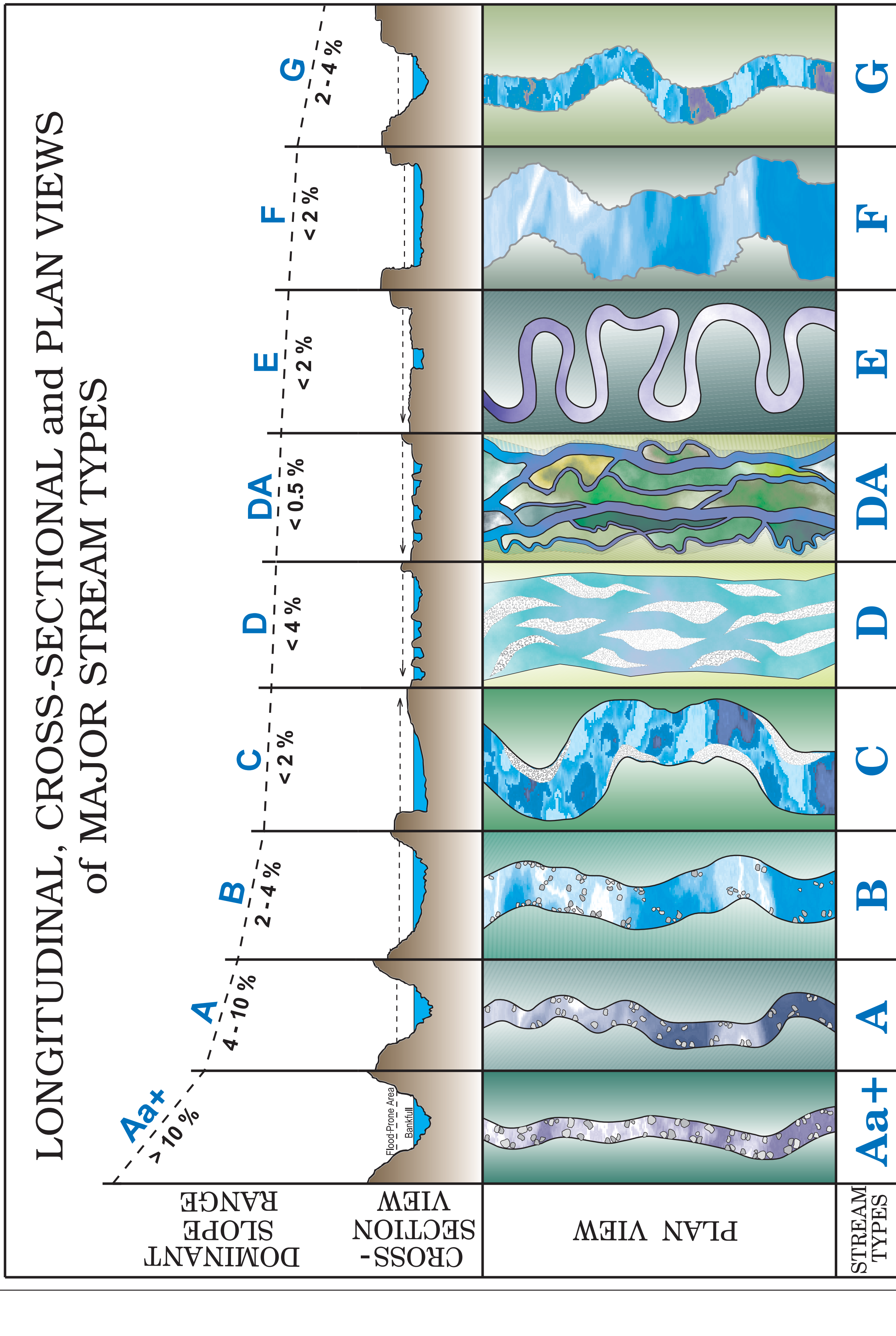


**Figure A-1.** Broad-level stream classification delineation showing longitudinal, cross-sectional and plan views of major stream types (Rosgen, 1994, 1996).

**Table A-1.** General stream type descriptions and delineative criteria for broad-level classification (Rosgen, 1994, 1996).

| Stream Type | General Description | Entrench-ment Ratio | W/D Ratio | Sinuosity | Slope | Landform / Soils / Features |
|---|---|---|---|---|---|---|
| **Aa+** | Very steep, deeply entrenched, debris transport, torrent streams. | <1.4 | <12 | 1.0 to 1.1 | >0.10 | Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls. |
| **A** | Steep, entrenched, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock- or boulder-dominated channel. | <1.4 | <12 | 1.0 to 1.2 | 0.04 to 0.10 | High relief. Erosional or depositional and bedrock forms. Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in associated step/pool bed morphology. |
| **B** | Moderately entrenched, moderate gradient, riffle-dominated channel, with infrequently spaced pools. Very stable plan and profile. Stable banks. | 1.4 to 2.2 | >12 | >1.2 | 0.02 to 0.039 | Moderate relief, colluvial deposition and/or structural. Moderate entrenchment and width/depth ratio. Narrow, gently sloping valleys. Rapids predominate with scour pools. |
| **C** | Low gradient, meandering, point bar, riffle/pool, alluvial channels with broad, well-defined floodplains. | >2.2 | >12 | >1.2 | <0.02 | Broad valleys with terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology. |
| **D** | Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks. | n/a | >40 | n/a | <0.04 | Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment with abundance of sediment supply. Convergence. Divergence of bed features, aggradational processes, high bedload and bank erosion. |
| **DA** | Anastomosing (multiple channels) narrow and deep with extensive, well-vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and width/depth ratios. Very stable streambanks. | >2.2 | Highly Variable | Highly Variable | <0.005 | Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomosed (multiple channel) geologic control creating fine deposition with well-vegetated bars that are laterally stable with broad wetland floodplains. Very low bedload, high washload sediment. |
| **E** | Low gradient, meandering riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander width ratio. | >2.2 | <12 | >1.5 | <0.02 | Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width/depth ratios. |
| **F** | Entrenched meandering riffle/pool channel on low gradients with high width/depth ratio. | <1.4 | >12 | >1.2 | <0.02 | Entrenched in highly weathered material. Gentle gradients with a high width/depth ratio. Meandering, laterally unstable with high bank erosion rates. Riffle/pool morphology. |
| **G** | Entrenched "gully" step/pool and low width/depth ratio on moderate gradients. | <1.4 | <12 | >1.2 | <0.039 | Gullies, step/pool morphology with moderate slopes and low width/depth ratio. Narrow valleys or deeply incised in alluvial or colluvial materials; i.e., fans or deltas. Unstable with grade control problems and high bank erosion rates. |

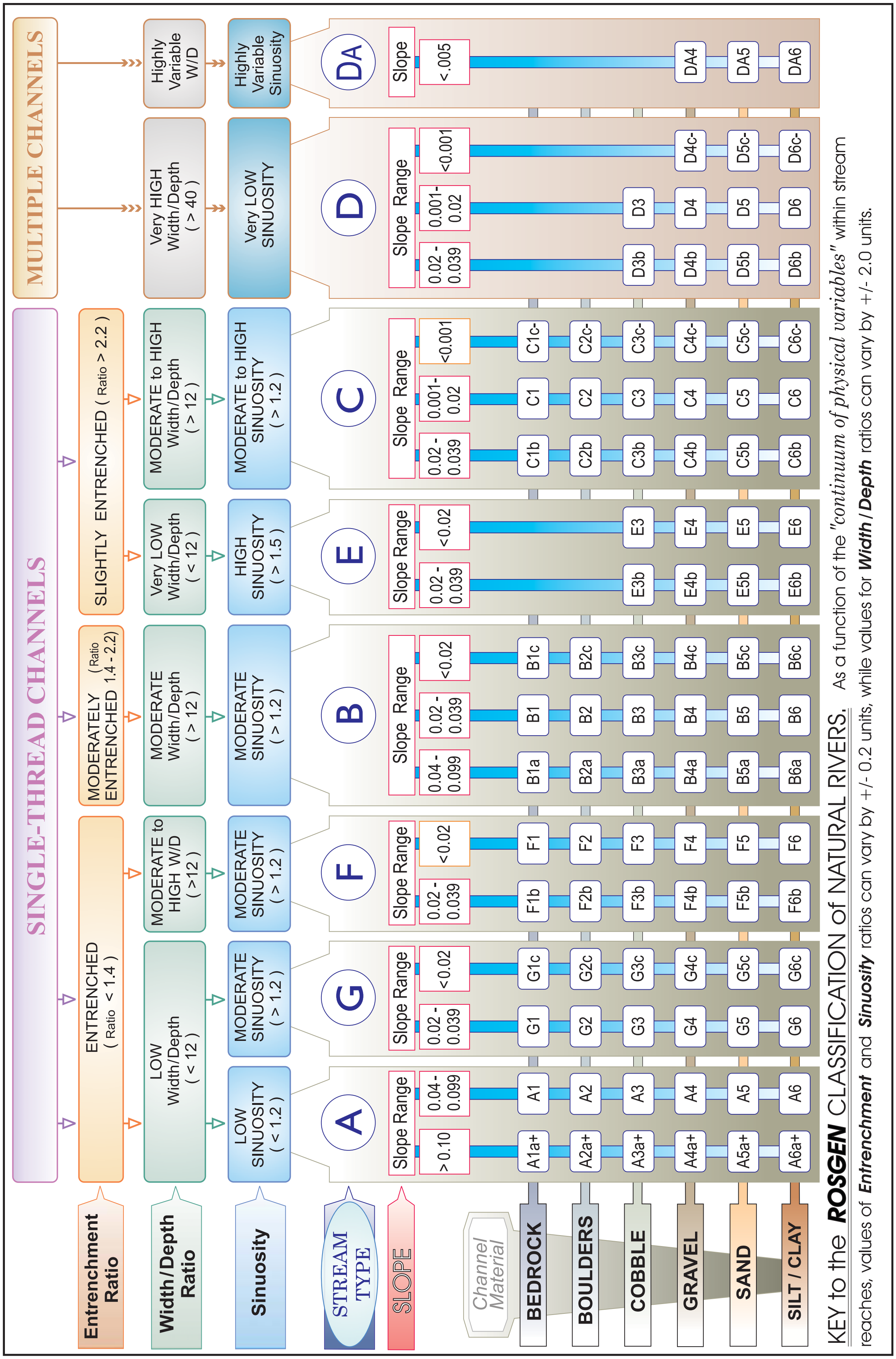


**Figure A-2.** Stream classification key for natural rivers (Rosgen, 1994, 1996).

**Table A-3.** Management interpretations of various stream types (Rosgen, 1994, 1996).

| Stream Type | Sensitivity to Disturbance[a] | Recovery Potential[b] | Sediment Supply[c] | Streambank Erosion Potential | Vegetation Controlling Influence[d] |
|---|---|---|---|---|---|
| A1 | very low | excellent | very low | very low | negligible |
| A2 | very low | excellent | very low | very low | negligible |
| A3 | very high | very poor | very high | very high | negligible |
| A4 | extreme | very poor | very high | very high | negligible |
| A5 | extreme | very poor | very high | very high | negligible |
| A6 | high | poor | high | high | negligible |
| B1 | very low | excellent | very low | very low | negligible |
| B2 | very low | excellent | very low | very low | negligible |
| B3 | low | excellent | low | low | moderate |
| B4 | moderate | excellent | moderate | low | moderate |
| B5 | moderate | excellent | moderate | moderate | moderate |
| B6 | moderate | excellent | moderate | low | moderate |
| C1 | low | very good | very low | low | moderate |
| C2 | low | very good | low | low | moderate |
| C3 | moderate | good | moderate | moderate | very high |
| C4 | very high | good | high | very high | very high |
| C5 | very high | fair | very high | very high | very high |
| C6 | very high | good | high | high | very high |
| D3 | very high | poor | very high | very high | moderate |
| D4 | very high | poor | very high | very high | moderate |
| D5 | very high | poor | very high | very high | moderate |
| D6 | high | poor | high | high | moderate |
| DA4 | moderate | good | very low | low | very high |
| DA5 | moderate | good | low | low | very high |
| DA6 | moderate | good | very low | very low | very high |
| E3 | high | good | low | moderate | very high |
| E4 | very high | good | moderate | high | very high |
| E5 | very high | good | moderate | high | very high |
| E6 | very high | good | low | moderate | very high |
| F1 | low | fair | low | moderate | low |
| F2 | low | fair | moderate | moderate | low |
| F3 | moderate | poor | very high | very high | moderate |
| F4 | extreme | poor | very high | very high | moderate |
| F5 | very high | poor | very high | very high | moderate |
| F6 | very high | fair | high | very high | moderate |
| G1 | low | good | low | low | low |
| G2 | moderate | fair | moderate | moderate | low |
| G3 | very high | poor | very high | very high | high |
| G4 | extreme | very poor | very high | very high | high |
| G5 | extreme | very poor | very high | very high | high |
| G6 | very high | poor | high | high | high |

[a] Includes increases in streamflow magnitude and timing and/or sediment increases.
[b] Assumes natural recovery once cause of instabiilty is corrected.
[c] Includes supsended and bedload from channel derived sources and/or from stream adjacent slopes.
[d] Vegetation that influences width/depth ratio-stability.

# Valley Types

Because stream morphology is invariably fixed to the landscape position, prior to the broad-level stream classification, valley types must be identified that integrate structural controls, fluvial process, depositional history, climate and broad life zones. Valley types are stratified into eleven broad geologic categories that reflect their origin and represent the independent boundary conditions that influence channel morphology (Rosgen 1994, 1996). **Table A-3** summarizes the valley types and their associated characteristics, separated by historic erosional or depositional processes and corresponding differences in valley slope, channel materials and width. Valley types and related landforms are the initial stratification of stream types (**Table A-3**). For example, highly dissected fluvial slopes (Valley Type VII) are indicative of steep, narrow, deeply incised, erosional A and G stream types. Narrow, low gradient streams in confined canyons and deep gorges (Valley Types IV) are characteristic of the entrenched F stream types.

**Table A-3.** Valley types used in the geomorphic characterization (Rosgen, 1996, 2006).

| Valley Types | Summary Description of Valley Types | Stream Types |
|---|---|---|
| I | Steep, confined, V-notched canyons, rejuvenated side-slopes | Aa+, A, G |
| II | Moderately steep, gentle-sloping side-slopes often in colluvial valleys | B, G |
| III | Alluvial fans and debris cones | A, B, F, G, D |
| IV | Canyons, gorges and confined alluvial and bedrock-controlled valleys with gentle valley slopes | C, F |
| V | Moderately steep, U-shaped glacial-trough valleys | C, D, F, G |
| VI | Moderately steep, fault- , joint- or bedrock-controlled valleys | Aa+, A, B, C, F, G |
| VII | Steep, fluvial dissected, high-drainage density alluvial slopes | Aa+, A, G |
| VIII | Alluvial valley fills either narrow or wide with moderate to gentle valley slope with well-developed floodplain adjacent to river, and river terraces, glacial terraces or colluvial slopes adjacent to the alluvial valley | C, D, E, F, G |
| IX | Broad, moderate to gentle slopes, associated with glacial outwash or eolian sand dunes | C, D, F |
| X | Very broad and gentle valley slopes associated with glacio- and nonglacio-lacustrine deposits | C, DA, D, E, F, G |
| XI | Deltas | C, D, DA, E |

The following Valley Type descritpions are extracted from Rosgen (1996, pp. 4-12 to 4-22). Note that Figure numbering has been changed from original publication.

# Valley Type I

A Type I valley is V-shaped, confined, and is often structurally controlled and/or associated with faults. Elevational relief is high, valley floor slopes are greater than 2 percent, and landforms may be steep, glacial scoured lands, and/or highly dissected fluvial slopes. Valley materials vary from bedrock to residual soils occurring as colluvium, landslide debris, glacial tills, and other similar depositional materials. Stream types commonly observed in Valley Type I include types "A" and "G," which are typically step/pool channels with steeper channel slopes exhibiting cascade bed features. Stream channel erosional processes vary from very low and stable to highly erodible, producing debris torrents or avalanches. Often the "A" stream types in certain hydro-physiographic provinces are the starting or conveyance zones for snow avalanches. Examples of Valley Type I are shown in **Figure A-3** and illustrated in **Figure A-4**.

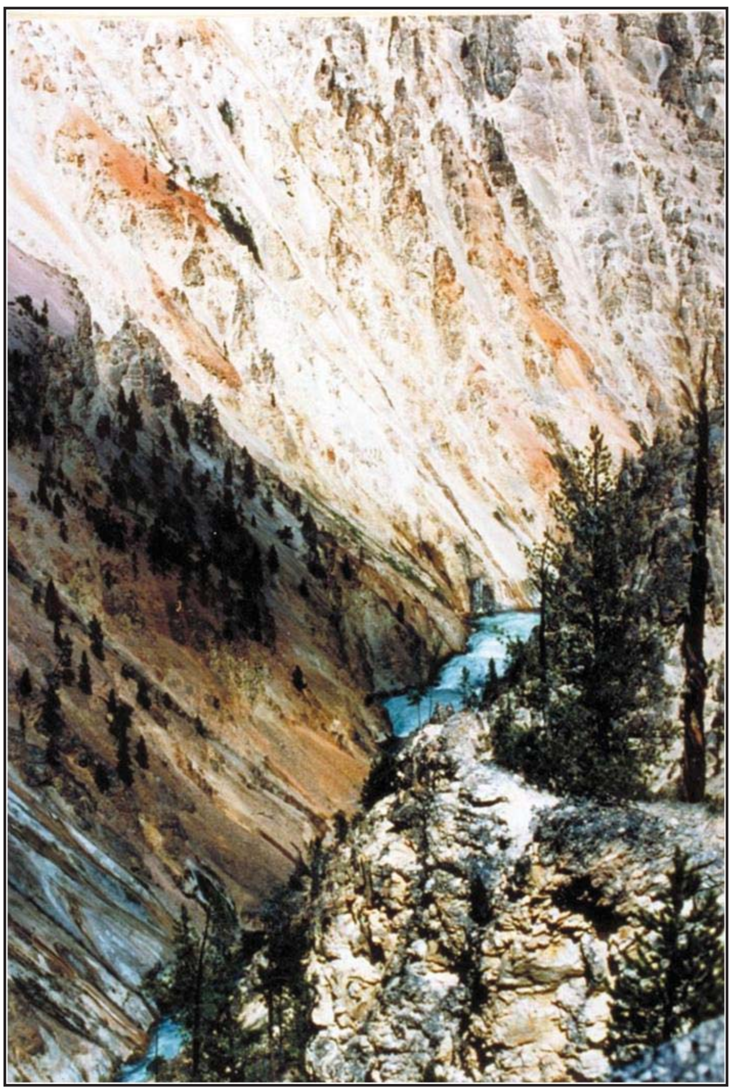

**Figure A-3.** Valley Type I, "V" notched canyons, rejuvenated side slopes (A and G stream types) (Rosgen, 1996).

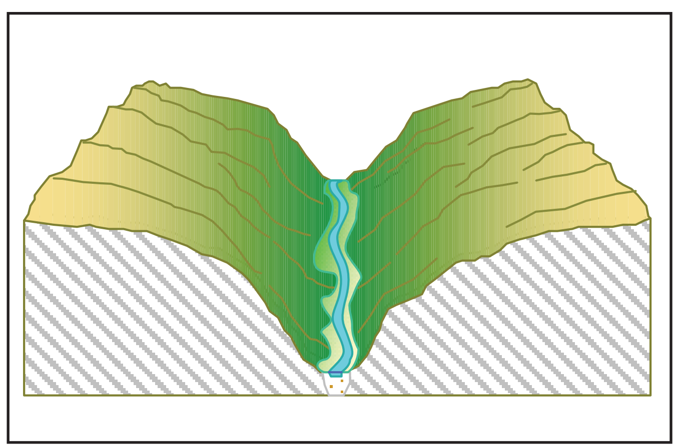

**Figure A-4.** Valley Type I, "V" notched canyons, rejuvenated side slopes (Rosgen, 1996).

# Valley Type II

Valley Type II exhibits moderate relief, relatively stable, moderate side slope gradients, and valley floor slopes that are often less than 4 percent with soils developed from parent material (residual soils), alluvium, and colluvium. Cryoplanated uplands dominated by colluvial slopes are typical of the land-types that generally comprise Valley Type II in the northern Rocky Mountains. The stream type most commonly found in Valley Type II are the "B" types, which are generally stable stream types, with a low sediment supply and bed features normally described as "rapids." Less common are "G" stream types that are observed generally under disequilibrium conditions. Examples of Valley Type II are shown in **Figure A-5** and the illustration in **Figure A-6**.

**Figure A-5.** Valley Type II, moderately steep, gentle sloping side slopes often in colluvial valleys (B stream types) (Rosgen, 1996).

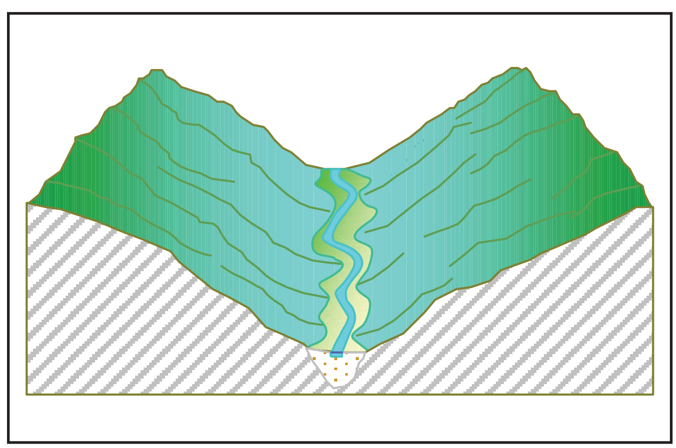

**Figure A-6.** Valley Type II, moderately steep, gentle sloping side slopes often in colluvial valleys (Rosgen, 1996).

# Valley Type III

Valley Type III is primarily depositional in nature with characteristic debris-colluvial or alluvial fan landforms, and valley-floor slopes that are moderately steep or greater than 2 percent. Stream types normally occurring in Valley type III are the "A," "B," "G," and "D" types. The "B" stream type, which is less common on alluvial or colluvial fans, occurs primarily on "non-building" stable fans and where riparian vegetation is well established along the drainage-way. The "G" stream type prevails where there is little established riparian vegetation in the presence of high bedload transport on actively "building" fans, similar to the multiple distributary channels of the "D" stream type. Examples of Valley Type III are shown in **Figure A-7** and the illustration in **Figure A-8**.

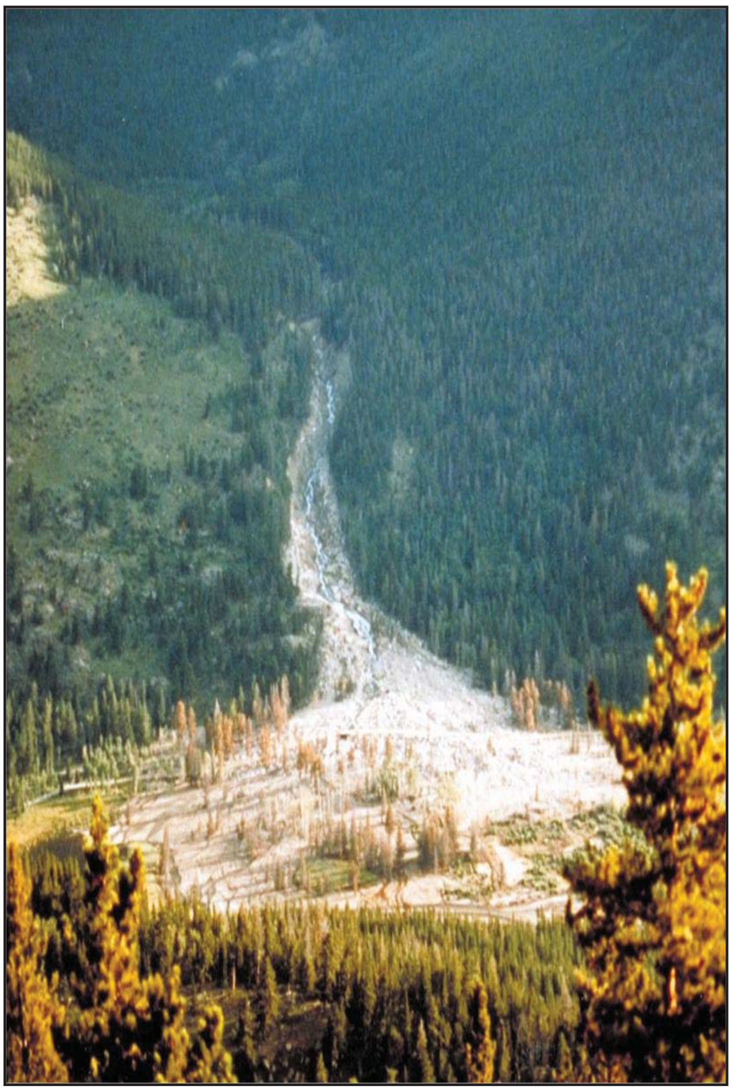

**Figure A-7.** Valley Type III, alluvial fans and debris cones (A, G, D and B stream types (Rosgen, 1996).

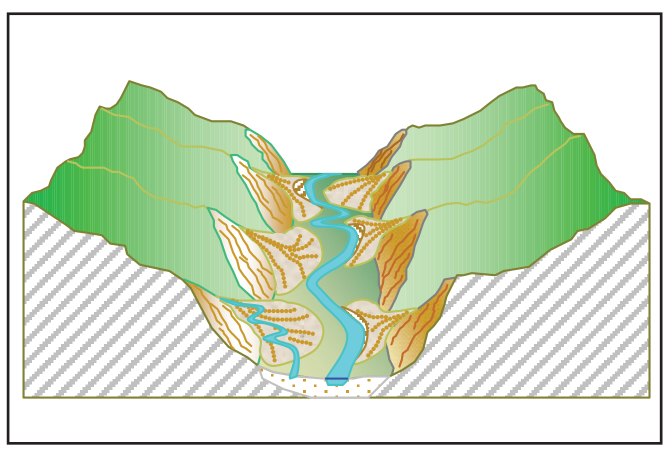

**Figure A-8.** Valley Type III, alluvial fans and debris cones (Rosgen, 1996).

# Valley Type IV

Valley Type IV consists of the classic meandering, entrenched or deeply incised, and confined landforms directly observed as canyons and gorges with gentle elevation relief and valley-floor gradients often less than 2 percent. Valley Type IV is generally structurally controlled and incised in highly weathered materials. These stream types are also often associated with tectonically "uplifted" valleys. The "F" stream type is most often found in Valley Type IV; however, where the width of the valley floor accommodates both the channel and a floodplain, C channels are often observed. Depending on streamside materials, the sediment supply is generally moderate to high. Examples of Valley Type IV are shown in **Figure A-9** and the illustration in **Figure A-10**.

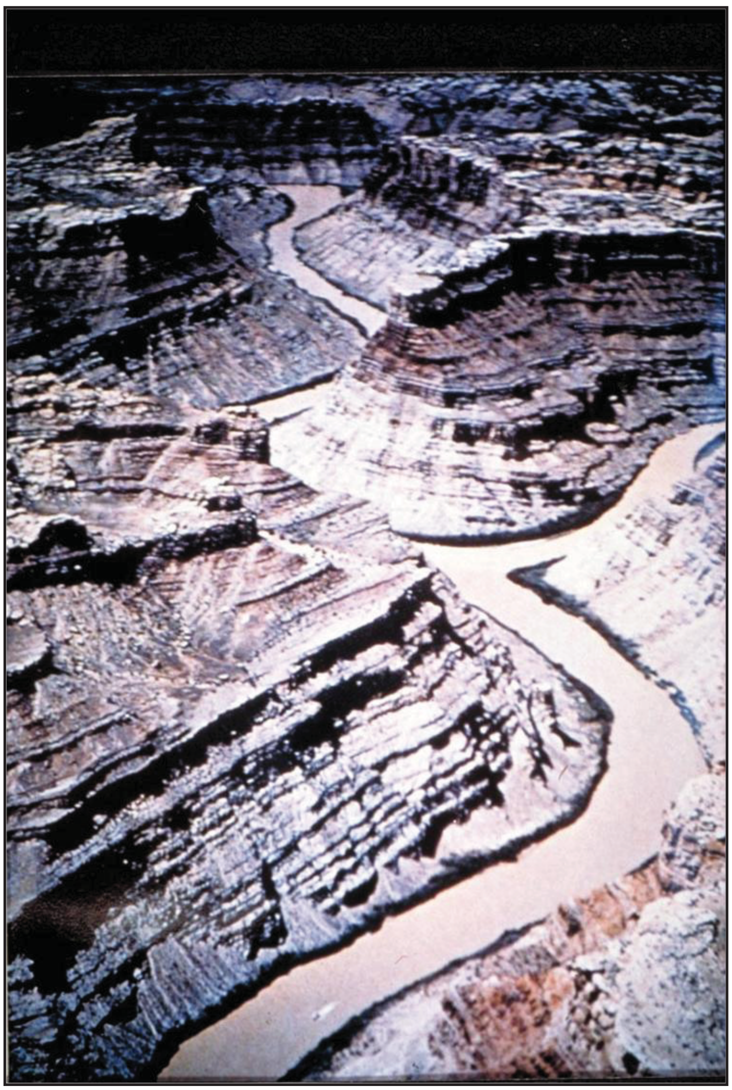

**Figure A-9.** Valley Type IV, gentle gradient canyons, gorges and confined alluvial valleys (F or C stream types) (Rosgen, 1996).

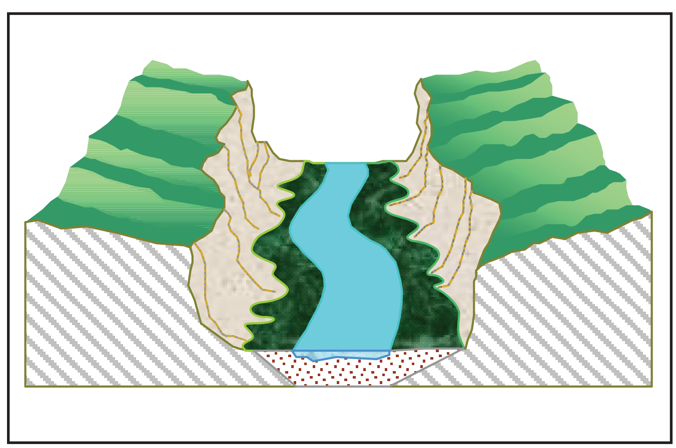

**Figure A-10.** Valley Type IV, gentle gradient canyons, gorges and confined alluvial valleys (Rosgen, 1996).

# Valley Type V

Valley Type V is the product of a glacial scouring process where the resultant trough is now a wide, "u-shaped" valley, with valley-floor slopes generally less than 4 percent. Soils are derived from materials deposited as moraines or more recent alluvium from the Holocene period to the present. Landforms locally include lateral and terminal moraines, alluvial terraces, and floodplains. Deep, coarse deposition of glacial till is common, as are glacio-fluvial deposits, with the finer size mixture of glacio-lacustrine deposition above structurally controlled reaches. The stream types most often seen in Valley Type V are "C," "D," and "G." Examples of Valley Type V are shown in **Figure A-11** and the illustration in **Figure A-12**.

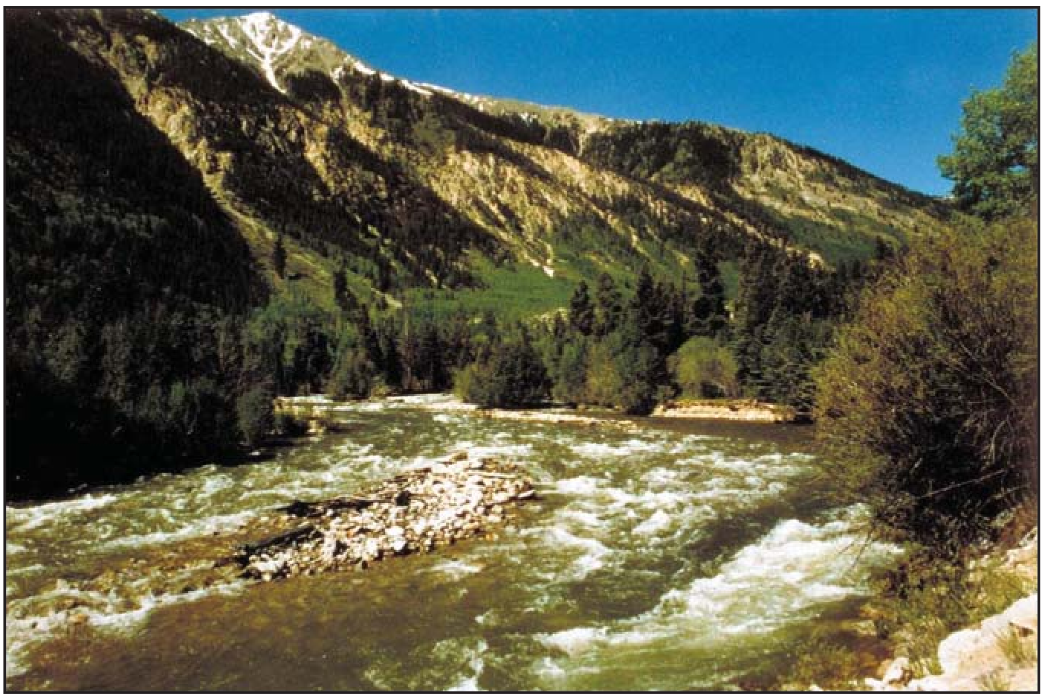

**Figure A-11.** Valley Type V, moderately steep valley slopes, "U" shaped glacial trough valleys (D and C stream types) (Rosgen, 1996).

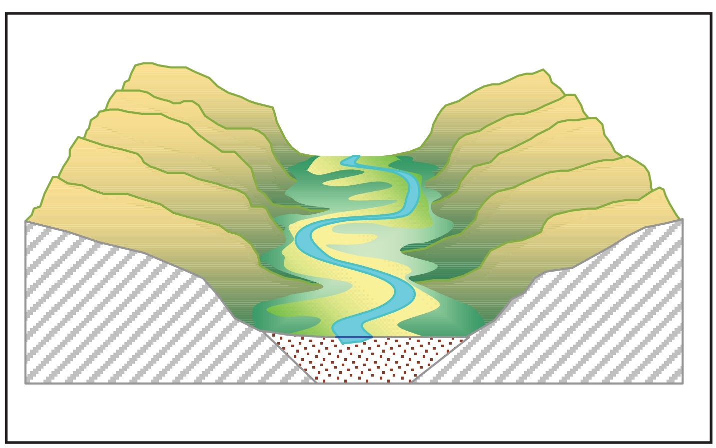

**Figure A-12.** Valley Type V, moderately steep valley slopes, "U" shaped glacial trough valleys (Rosgen, 1996).

# Valley Type VI

Valley Type VI, termed a fault-line valley, is structurally controlled and dominated by bedrock and/or colluvial slope building processes. The valley-floor gradients are moderate, often less than 4 percent, but can be steep. Some alluvium occurs amidst the extensive colluvial deposits and stream patterns are controlled by the confined, laterally controlled valley. Sediment supply is low. Stream types are predominantly "B" types with fewer occasions of "C" and "F" types in the wider and flatter valley reaches. Under steeper gradients, "A" and "G" stream types are observed. Examples of Valley Type VI are shown in **Figure A-13** and the illustration in **Figure A-14**.

**Figure A-13.** Valley Type VI, moderately steep, fault controlled valleys (B, G and C stream types) (Rosgen, 1996).

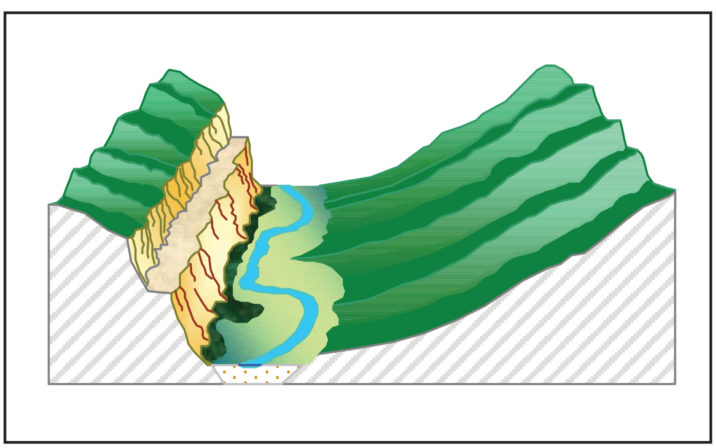

**Figure A-14.** Valley Type VI, moderately steep, fault controlled valleys (Rosgen, 1996).

# Valley Type VII

Valley Type VII consists of a steep to moderately steep landform, with highly dissected fluvial slopes, high drainage density, and a very high sediment supply. Streams are characteristically deeply incised in either colluvium and alluvium or in residual soils. The residual soils are often derived from sedimentary rocks such as marine shale. Depositional soils associated with these highly dissected slopes can often be eolian deposits of sand and/or marine sediments. This valley type can be observed over a variety of locations, from the provinces of the Palouse Prairie of Idaho, the Great Basin or high deserts of Nevada and Wyoming, the Sand Hills of Nebraska, to the Badlands of the Dakotas. The majority of stream types found in Valley Type VII are the "A" and "G" types, which are channels that have moderate to steep gradients, are entrenched (deeply incised), confined, and unstable due to the active lateral and vertical accretion processes. Examples of Valley Type VII are shown in **Figure A-15** and the illustration in **Figure A-16**.

**Figure A-15.** Valley Type VII, steep, highly dissected fluvial slopes (A and G stream types) (Rosgen, 1996).

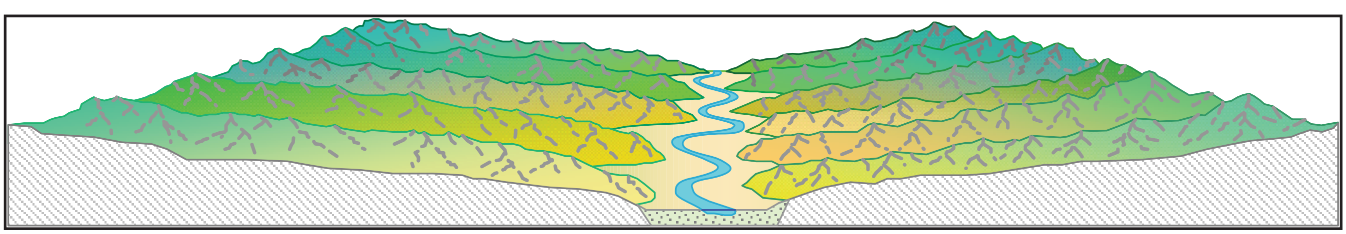

**Figure A-16.** Valley Type VII, steep, highly dissected fluvial slopes (Rosgen, 1996).

# Valley Type VIII

Valley type VIII is most readily identified by the presence of multiple river terraces positioned laterally along broad valleys with gentle, down-valley elevation relief. Alluvial terraces and floodplains are the predominant depositional landforms, which produce a high sediment supply. Glacial terraces can also occur in these valleys but stand much higher above the present river than the alluvial (Holocene) terraces. Soils are developed predominantly over alluvium originating from combined riverine and lacustrine depositional processes. Stream types "C" or "E," which have slightly entrenched, meandering channels that develop a riffle/pool bed-form, are normally seen in the Type VIII valley. However, "D," "F," and "G" stream types can also be found, depending on local stream and riparian conditions. Examples of Valley Type VIII are shown in **Figure A-17** and the illustration in **Figure A-18**.

**Figure A-17.** Valley Type VIII, wide, gentle valley slope with a well developed floodplain adjacent to river terraces (Rosgen, 1996).

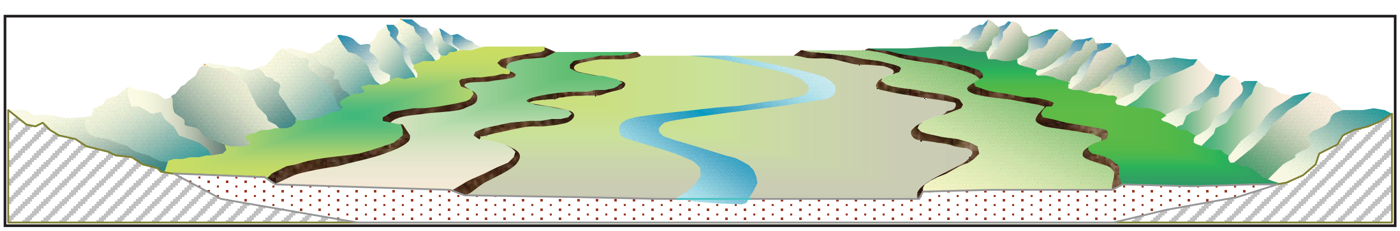

**Figure A-18.** Valley Type VIII, wide, gentle valley slope with a well developed floodplain adjacent to river terraces (Rosgen, 1996).

# Valley Type IX

Valley Type IX is observed as glacial outwash plains and/or dunes, where soils are derived from glacial, alluvial, and/or eolian deposits. Due to the depositional nature of the developed landforms, sediment supply is high, and the commonly occurring "C" and "D" stream types are associated with high rates of lateral migration. Examples of Valley Type IX are shown in **Figure A-19** and the illustration in **Figure A-20**.

**Figure A-19.** Valley Type IX, broad, moderate to gentle slopes, associated with glacial outwash and/or eolian sand dunes (predominately D and some C stream types) (Rosgen, 1996).

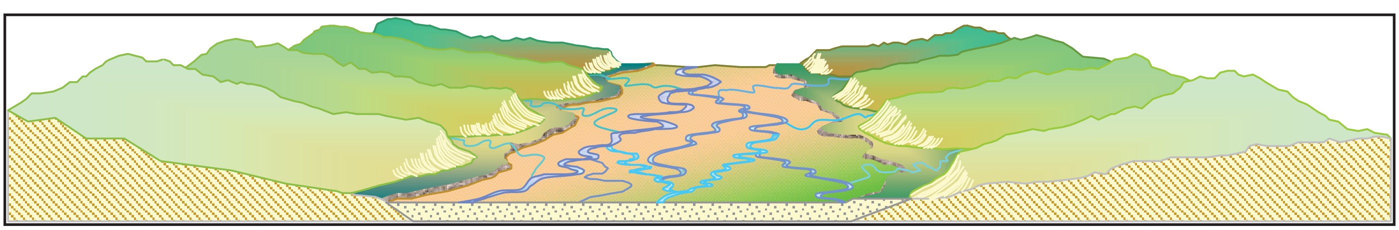

**Figure A-20.** Valley Type IX, broad, moderate to gentle slopes, associated with glacial outwash and/or eolian sand dunes (Rosgen, 1996).

# Valley Type X

Valley Type X is very wide with very gentle elevation relief and is mostly constructed with alluvial materials originating from both riverine and lacustrine deposition processes. Soils are primarily alluvium, and while less common, may also be derived from eolian deposition. Landforms commonly observed as Valley Type X are coastal plains, broad lacustrine and/or alluvial flats, which may exhibit peat bogs and expansive wetlands. Stream types “C,” “E,” and “DA” are the most commonly observed, although in many instances, where streams have been “channelized” or the local base level has been changed, “G” and “F” stream types are found. Examples of Valley Type X are shown in **Figure A-21** and the illustration in **Figure A-22**.

**Figure A-21.** Valley Type X, very broad and gentle slopes, associated with extensive floodplains - Great Plains, semi-desert and desert provinces; coastal plains and tundra (Rosgen, 1996).

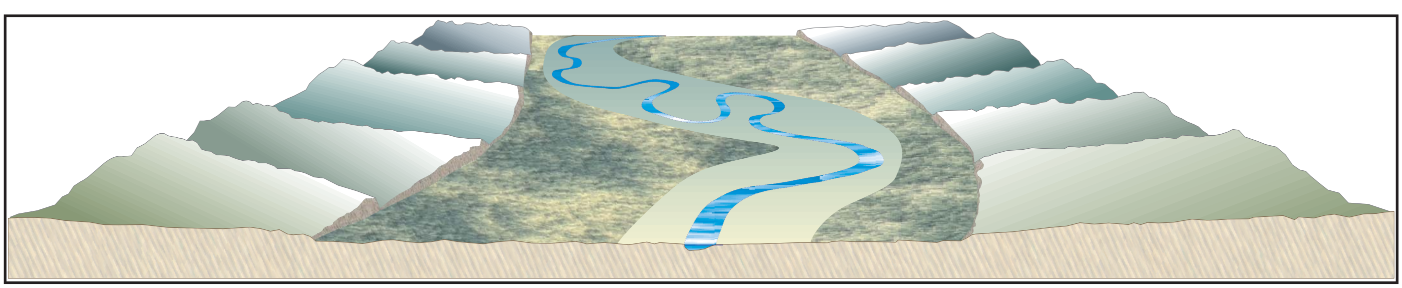

**Figure A-22.** Valley Type X, very broad and gentle slopes, associated with extensive floodplains - Great Plains, semi-desert and desert provinces; coastal plains and tundra (Rosgen, 1996).

# Valley Type XI

Valley type XI is a unique series of landforms consisting of large river deltas and tidal flats constructed of fine alluvial materials originating from riverine and estuarine depositional processes. The Type XI valleys or delta areas are often seen as freshwater and saltwater marshes, natural levees, and crevasse splays. There are four morphologically distinct delta areas, initially described by Fisher *et al*. (1969), which produce different stream types or patterns and include: the elongated, high-constructive delta (**Figure A-23**); the lobate, high constructive delta (**Figure A-24**); the wave-dominated, high destructive delta (**Figure A-25**); and the tide-dominated, high-constructive delta (**Figure A-26**). An additional delta landform is presented here, representative of extensive wetlands, peat, and cohesive sediments with multiple, stable channels typical of the "DA" (anastomosed) stream type (**Figure A-27**).

The corresponding stream types found in delta areas are primarily the distributary channels of stream type "DA," or the multiple channel systems of the "D" stream type, along with occasional "C" and "E" stream types. The "DA" stream type is more common to the delta landforms shown in **Figure A-27**, which are the tide-dominated, stable deltas with numerous wetland islands, and the base level of the channel system controlled by either lake or sea levels.

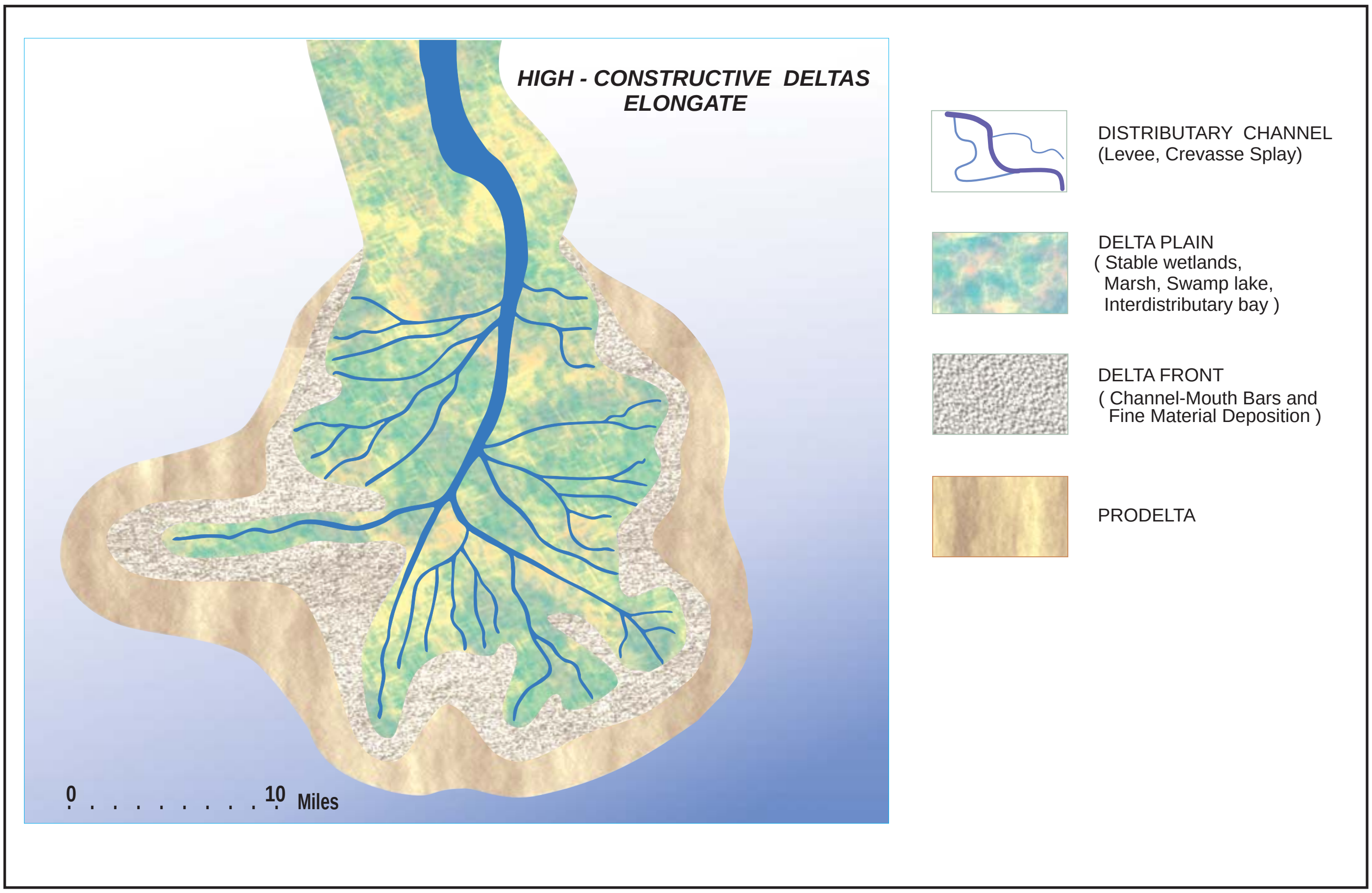


**Figure A-23.** Valley Type XI, Deltas - elongated, highly constructive delta with a distributary channel system (adapted from Fisher *et al*., 1969; Rosgen, 1996).

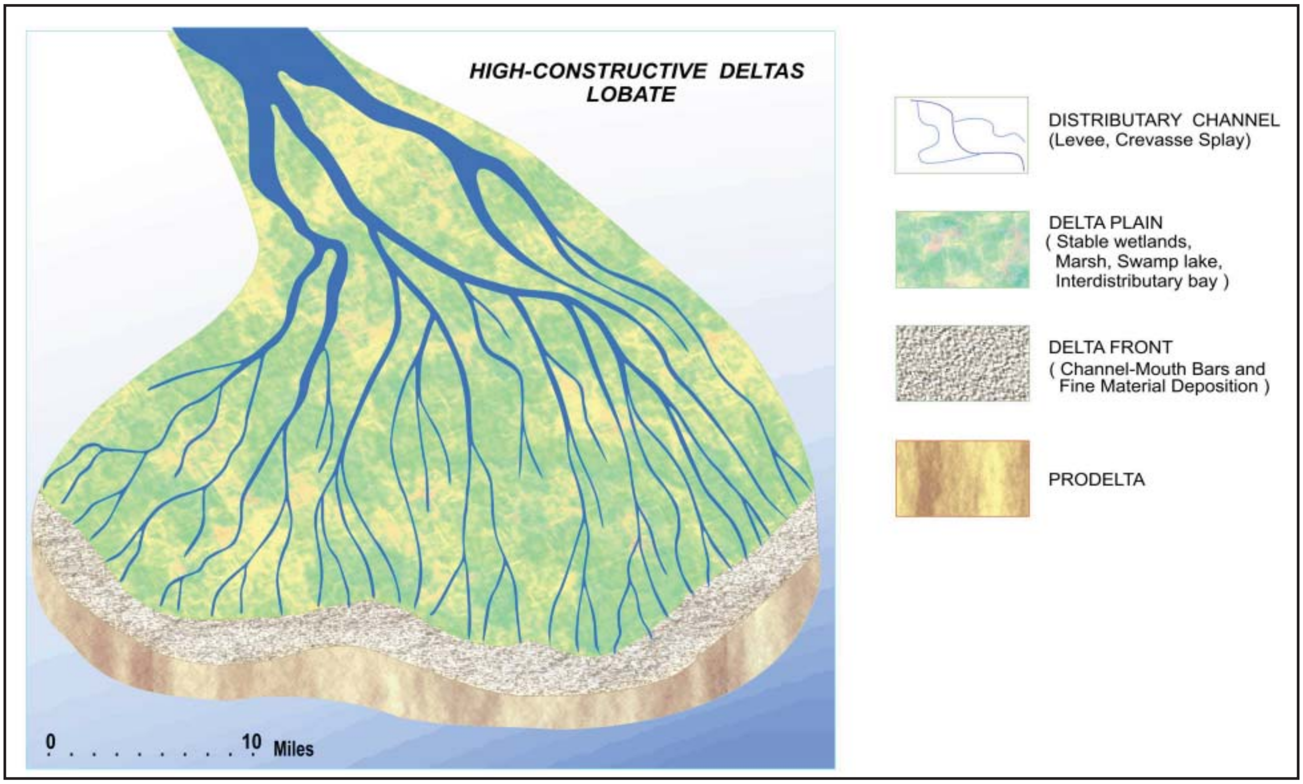


**Figure A-24.** Valley Type XI, Deltas - highly constructive deltas with a lobate configuration and distributary channel system (adapted from Fisher *et al*., 1969; Rosgen, 1996).

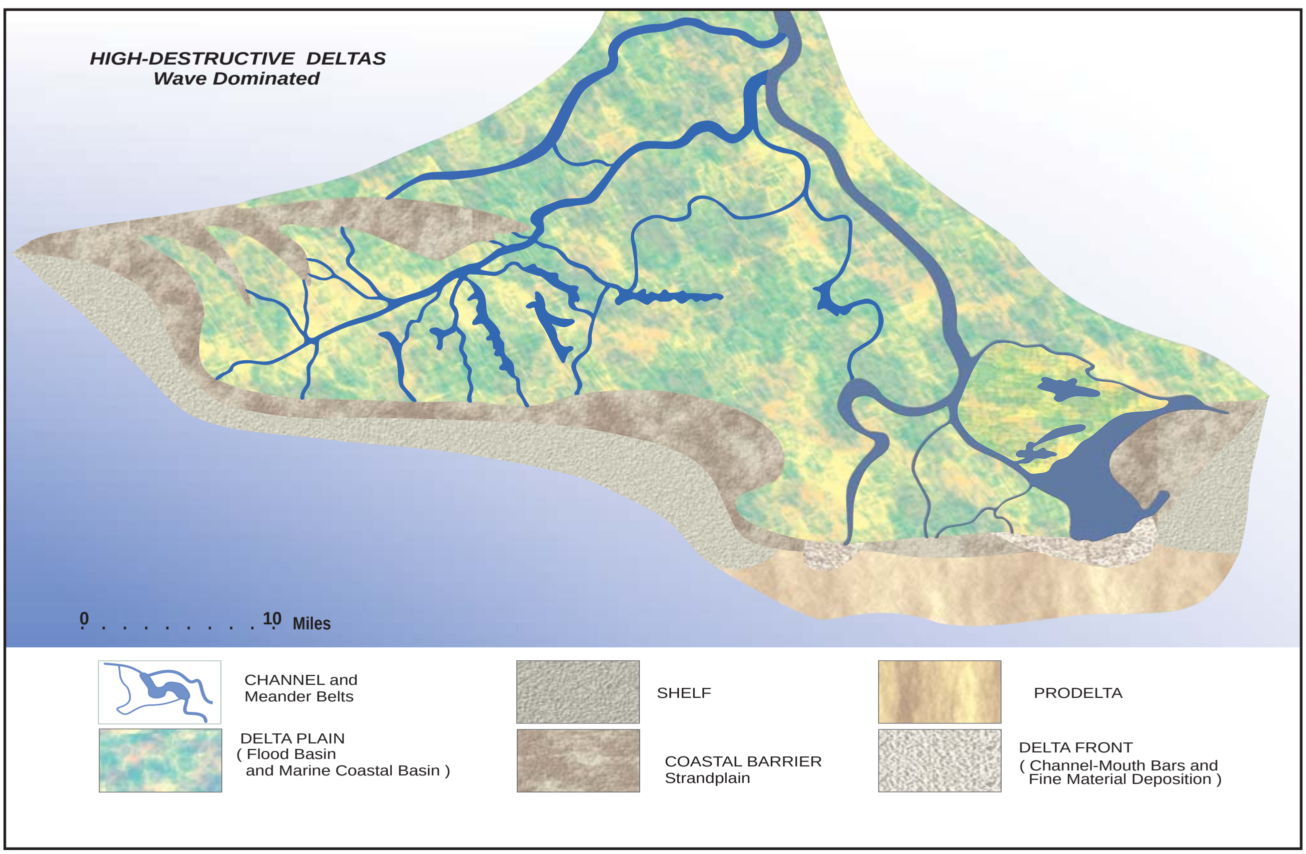


**Figure A-25.** Valley Type XI, Deltas - highly destructive, wave-dominated delta (adapted from Fisher *et al*., 1969; Rosgen, 1996).

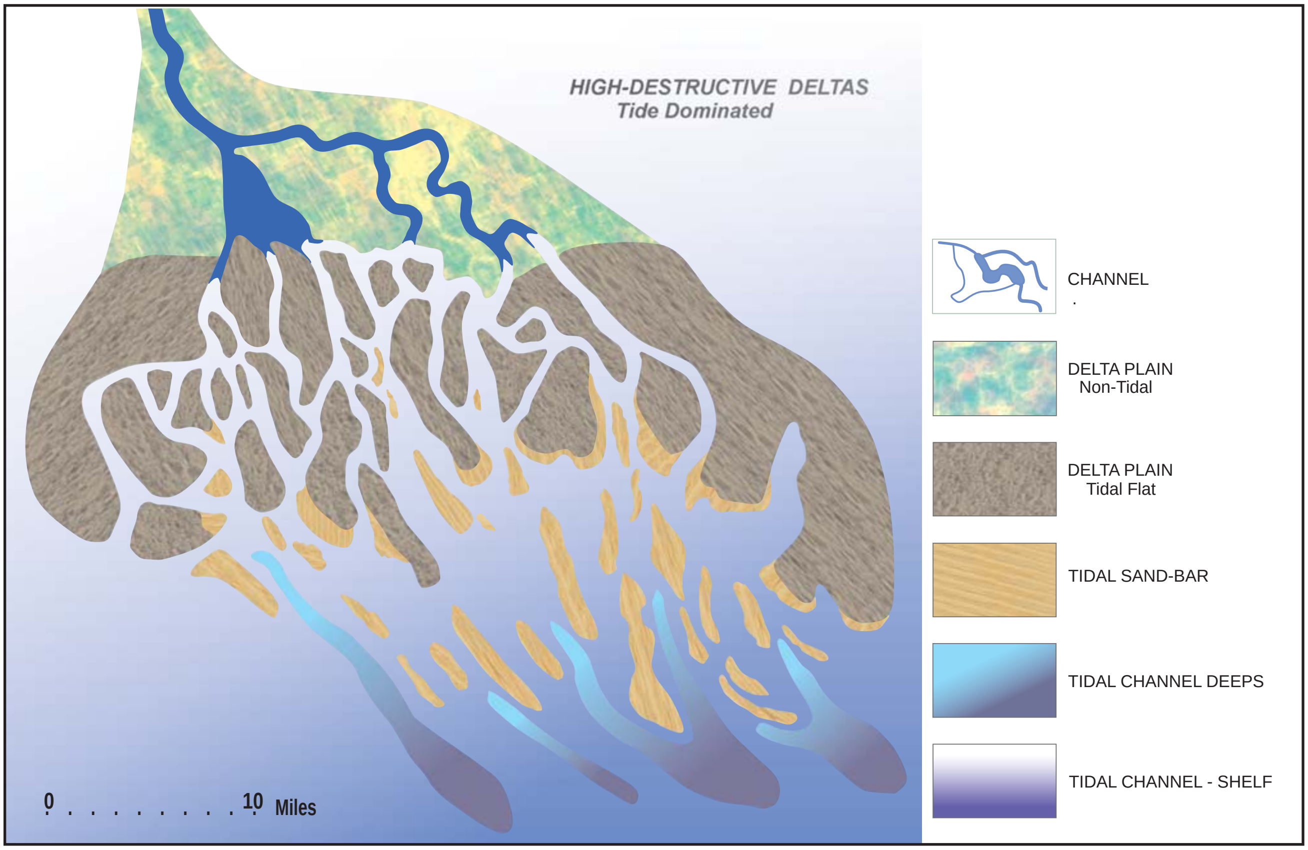


**Figure A-26.** Valley Type XI, Deltas - highly destructive, tide-dominated delta (adapted from Fisher *et al*., 1969; Rosgen, 1996).

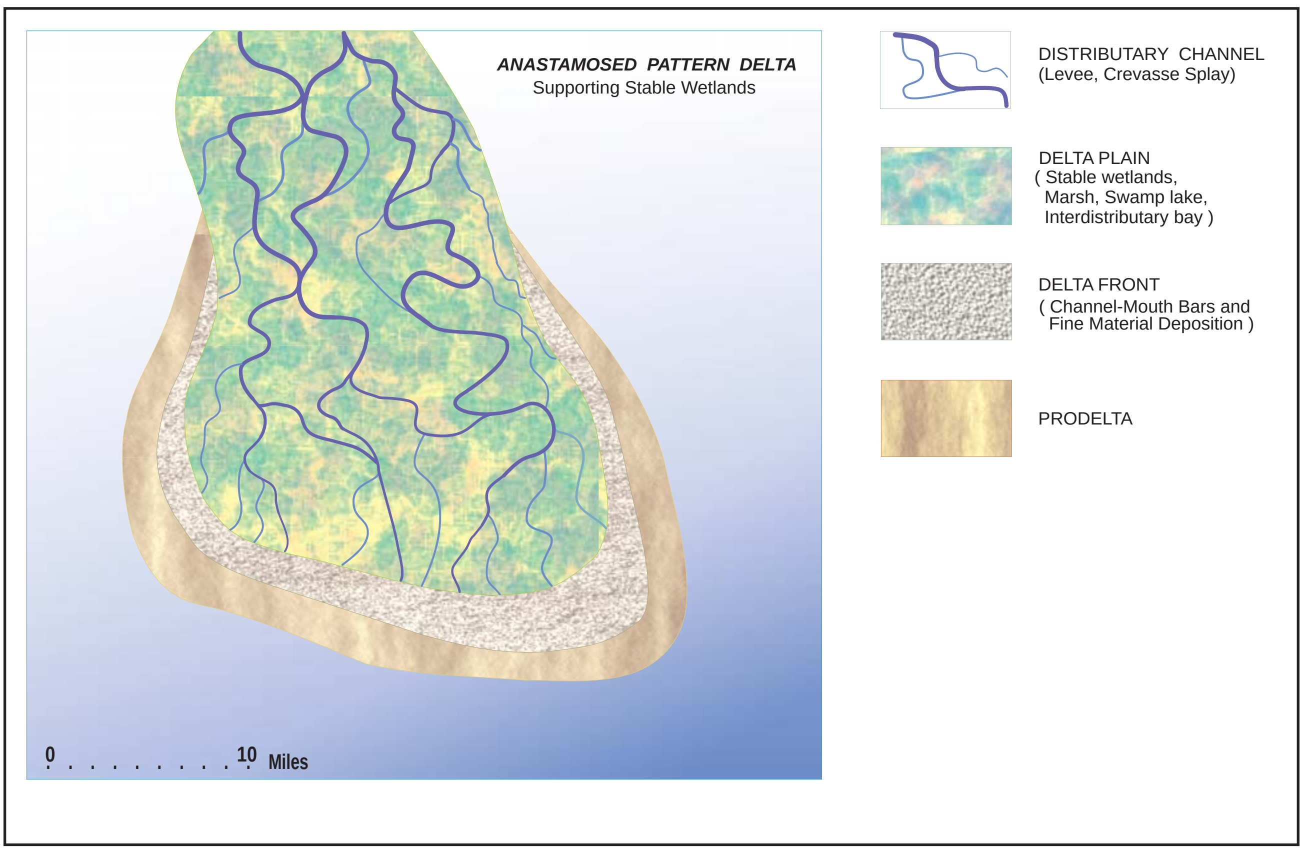


**Figure A-27.** Valley Type XI, Deltas - anastomosed river delta pattern with supporting stable wetlands and channels (adapted from Fisher *et al*., 1969; Rosgen, 1996).